Who We Are Today is Who We Were When
Abstract for Presentation to Goddard Contractors Association
Frank Cepollina
August 19, 2015

This talk presents the past, present, and future of satellite servicing. The presentation will also explain the resulting spin-off benefits of the past servicing missions. This presentation hopes to inspire the attendees about the exciting new work of the future.

Who We Are Today is Who We Were When

(This is What We're All About!)

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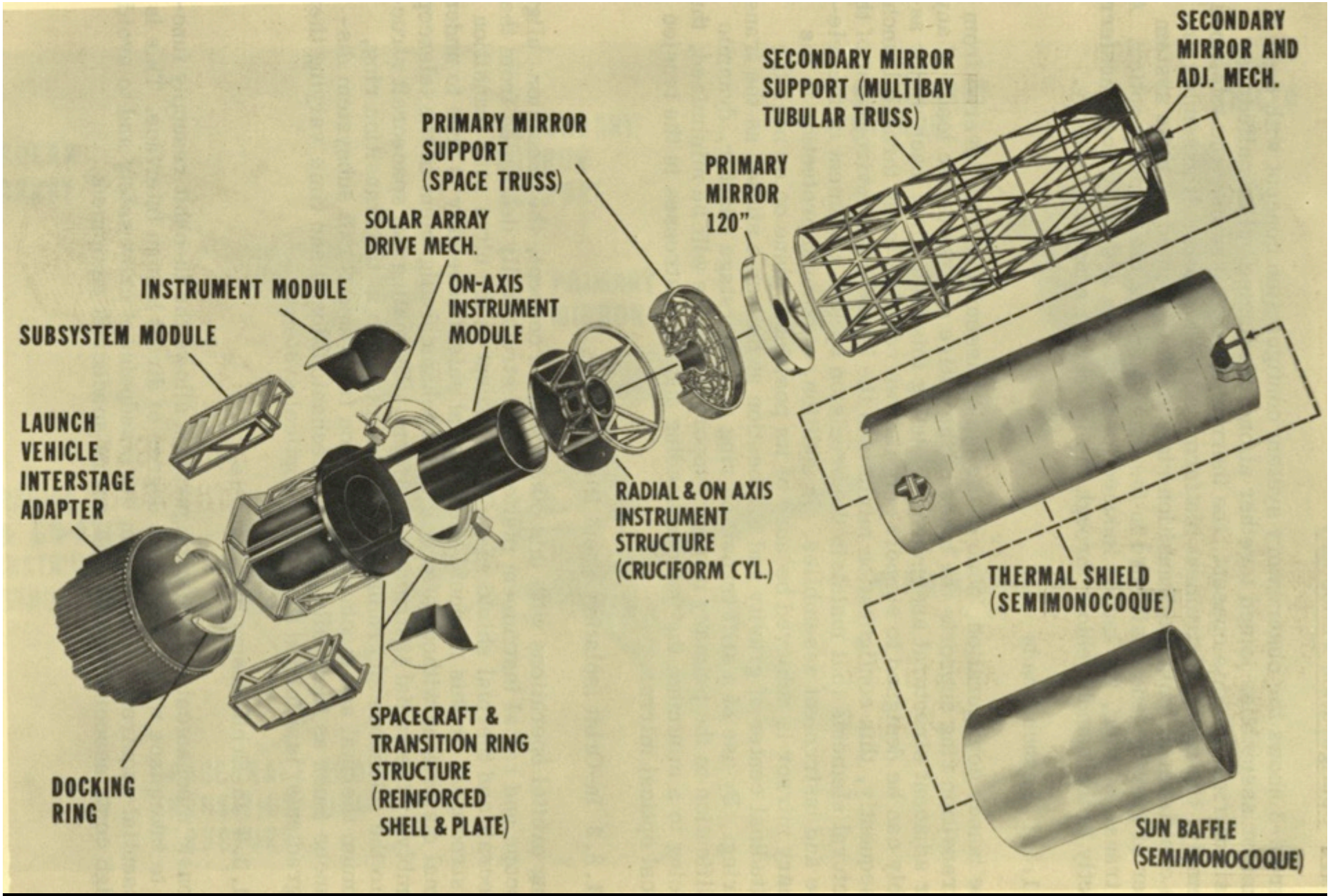
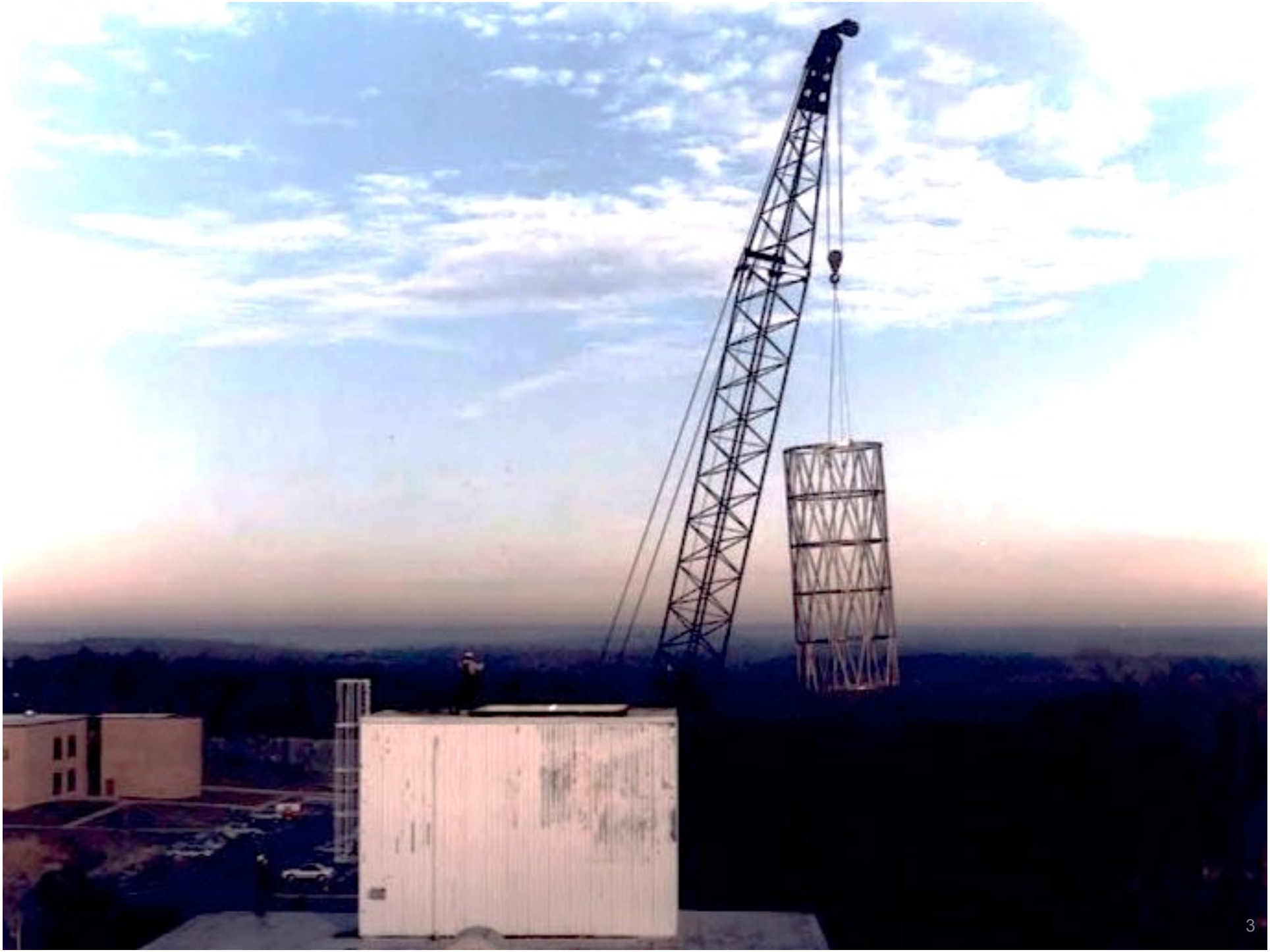
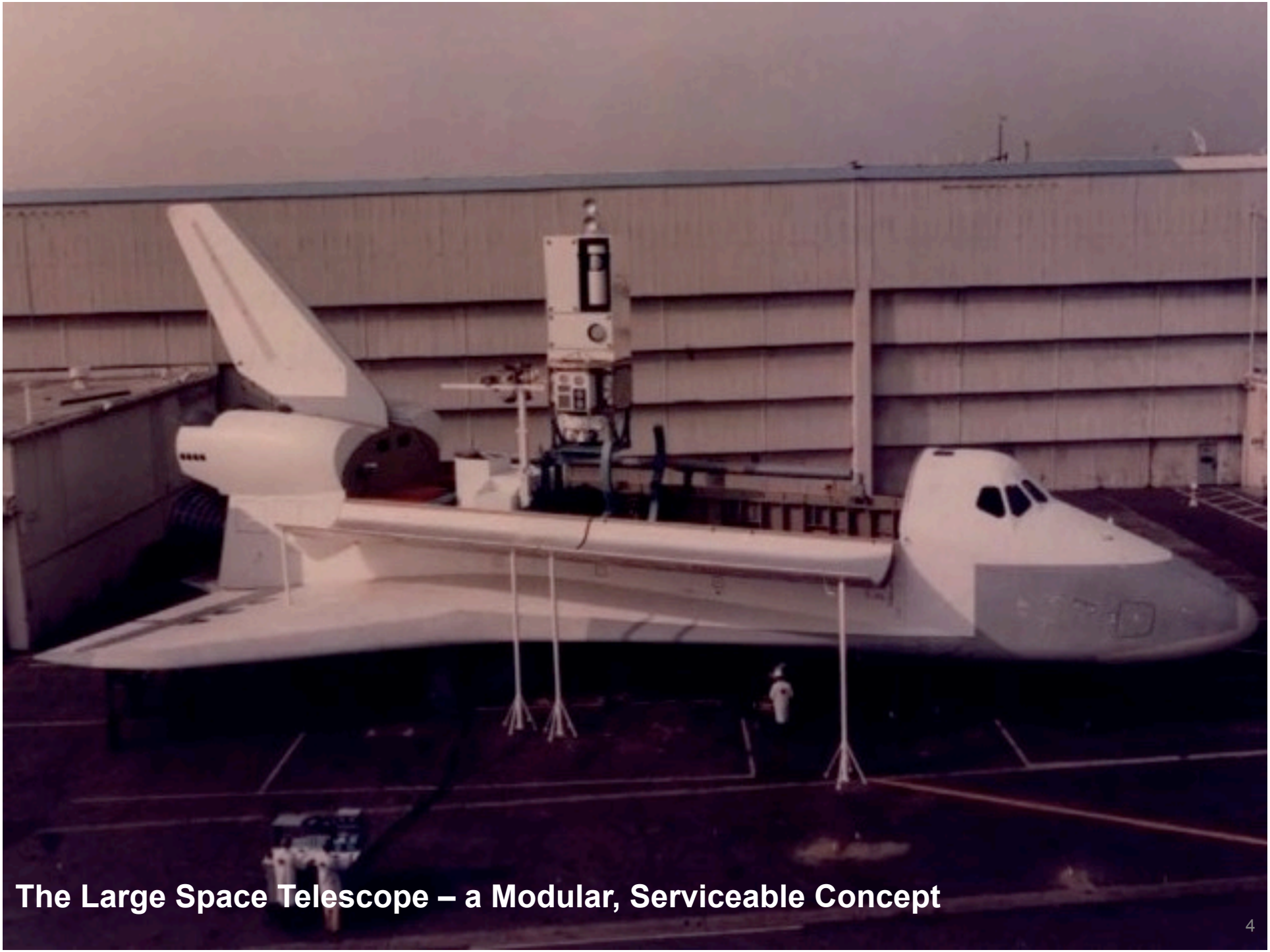
NASA's Goddard Space Flight Center | **Satellite Servicing Capabilities Office (SSCO)**



The Large Space Telescope – a Modular, Serviceable Concept





The Large Space Telescope – a Modular, Serviceable Concept

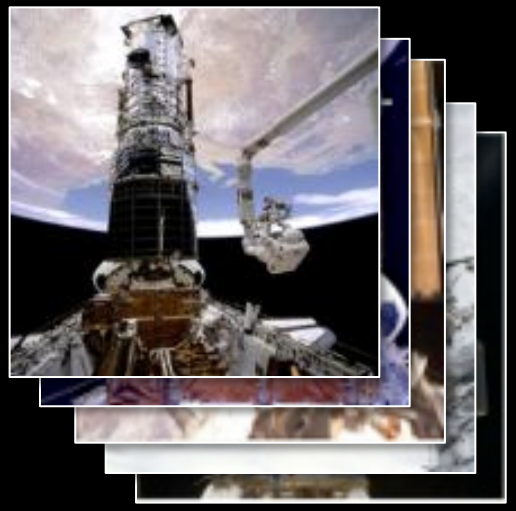
Solar Max 1984

Westar 6 & Palapa 2B
1984

Syncom IV 1985

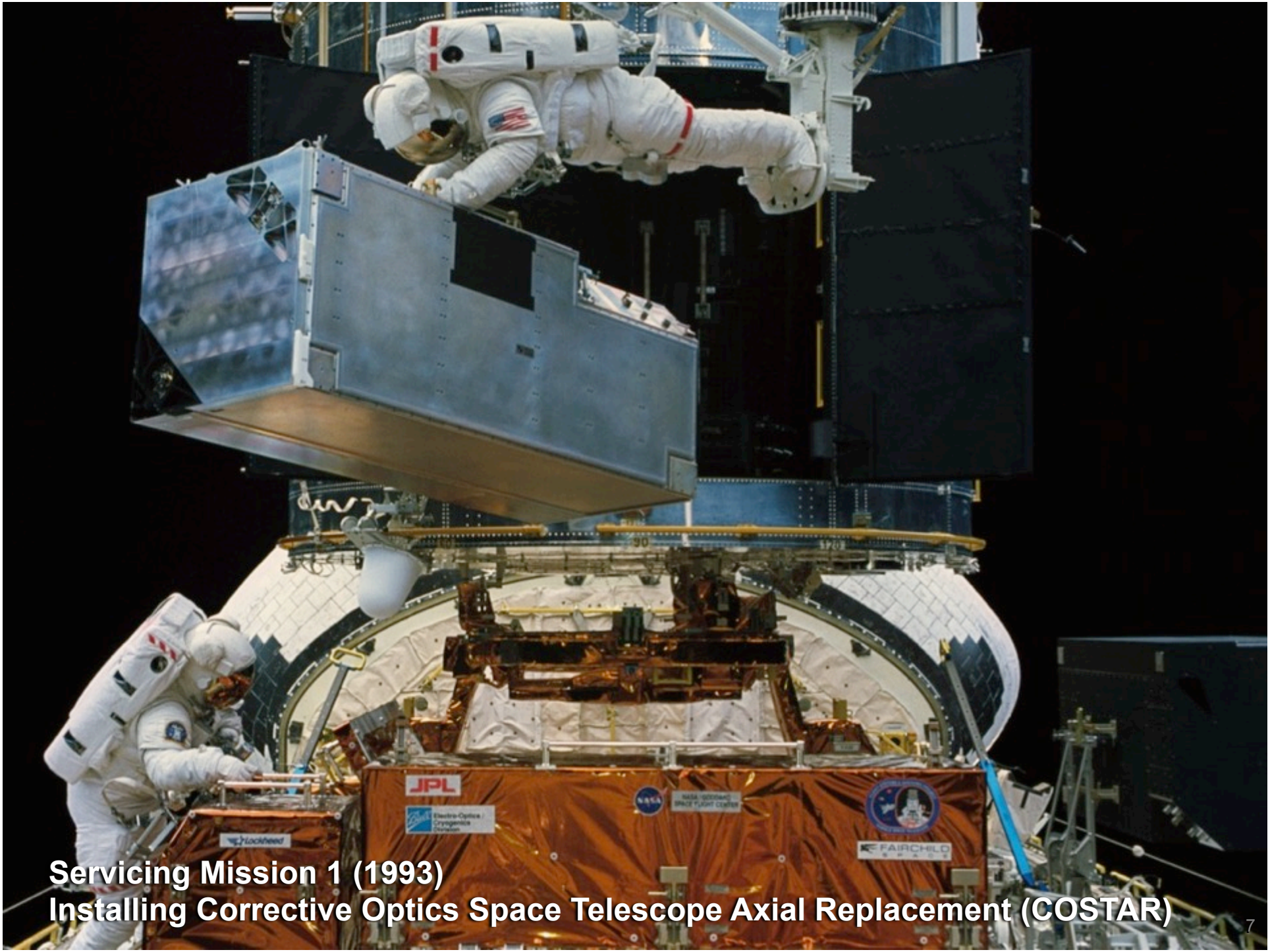
GRO 1991

Intelsat 603 1992

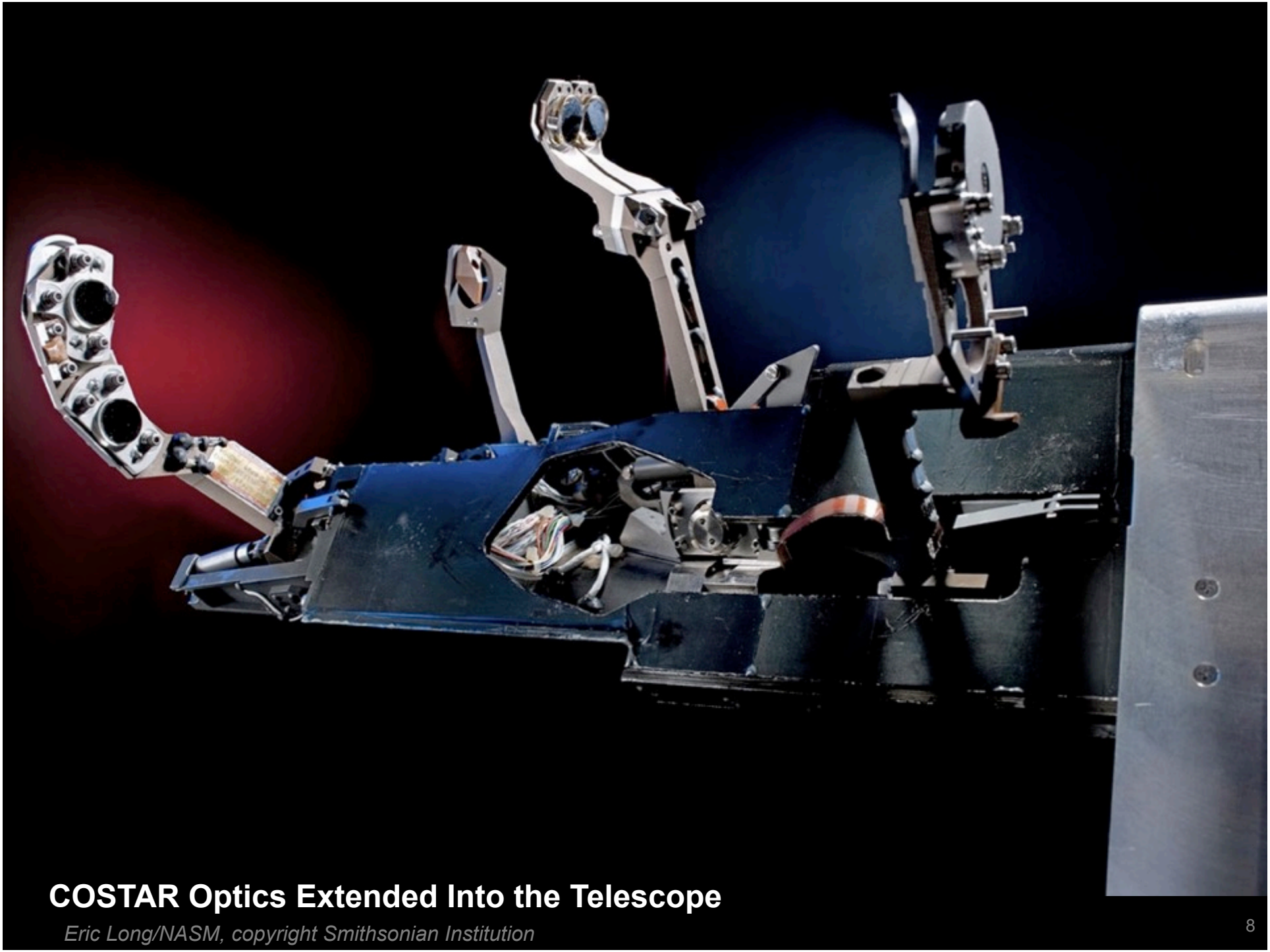


Hubble Servicing
Missions
1993 - 2009

Rich history of on-orbit satellite servicing.



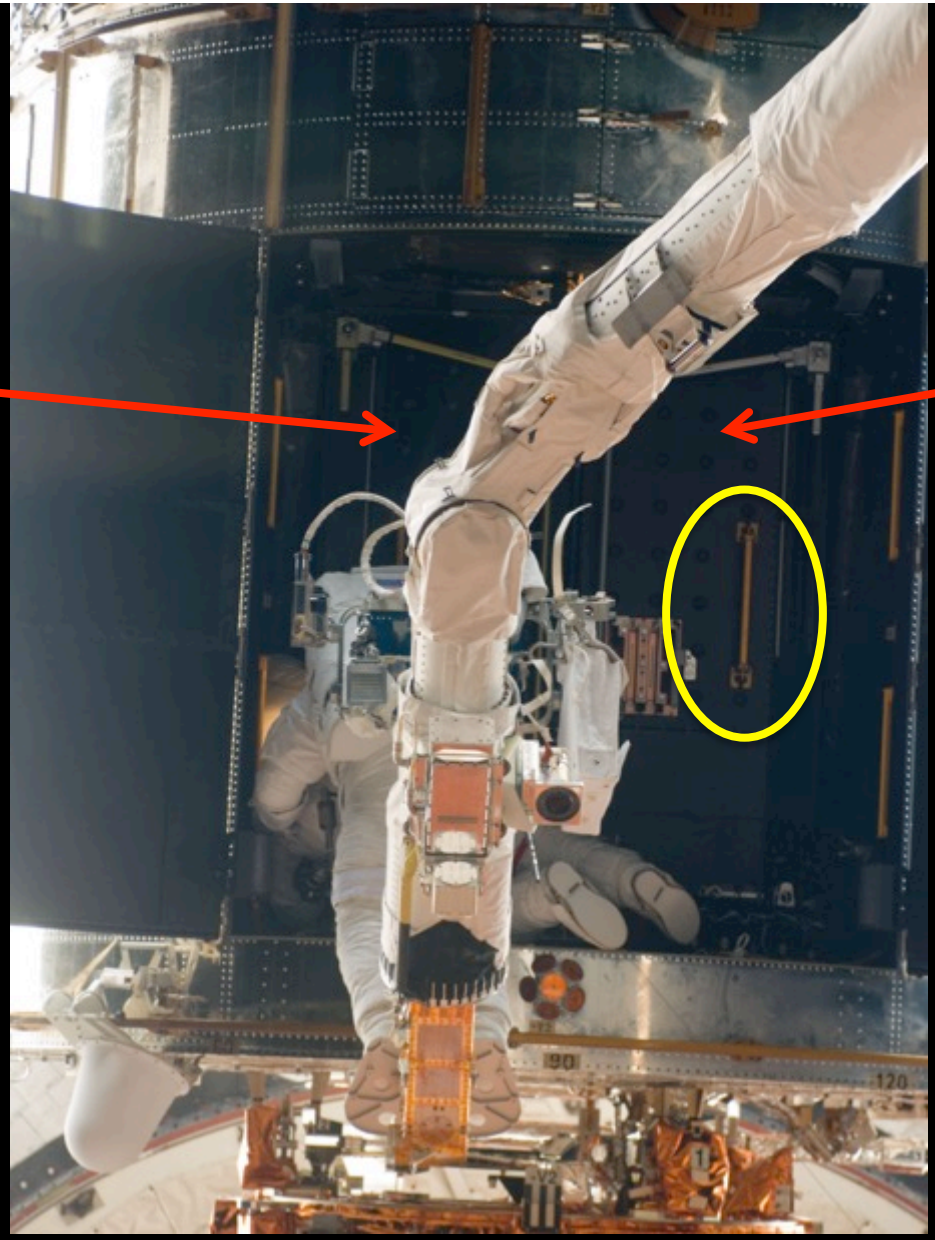
Servicing Mission 1 (1993)
Installing Corrective Optics Space Telescope Axial Replacement (COSTAR)



COSTAR Optics Extended Into the Telescope

Eric Long/NASM, copyright Smithsonian Institution

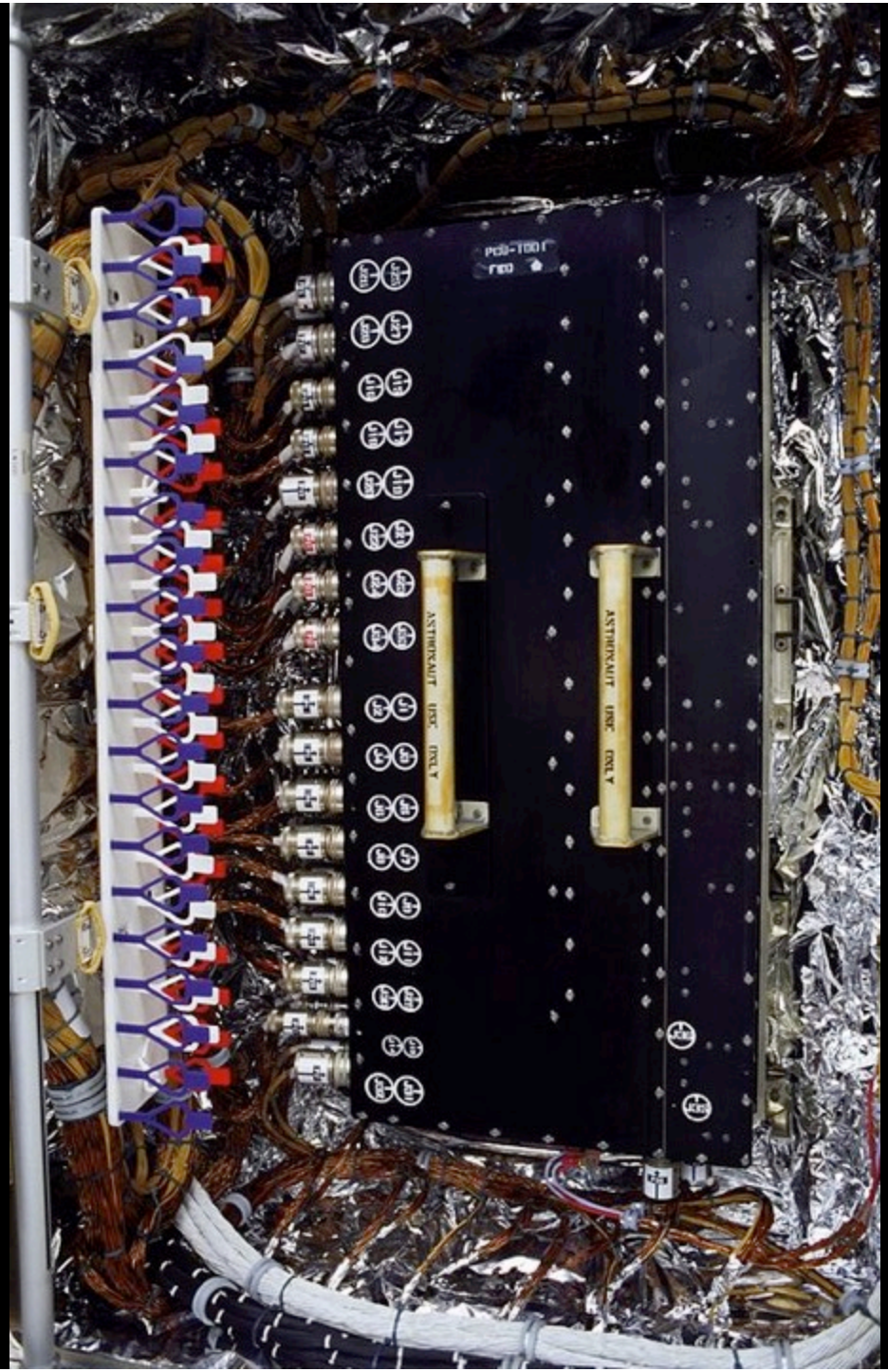
Hubble's Corrective Optics



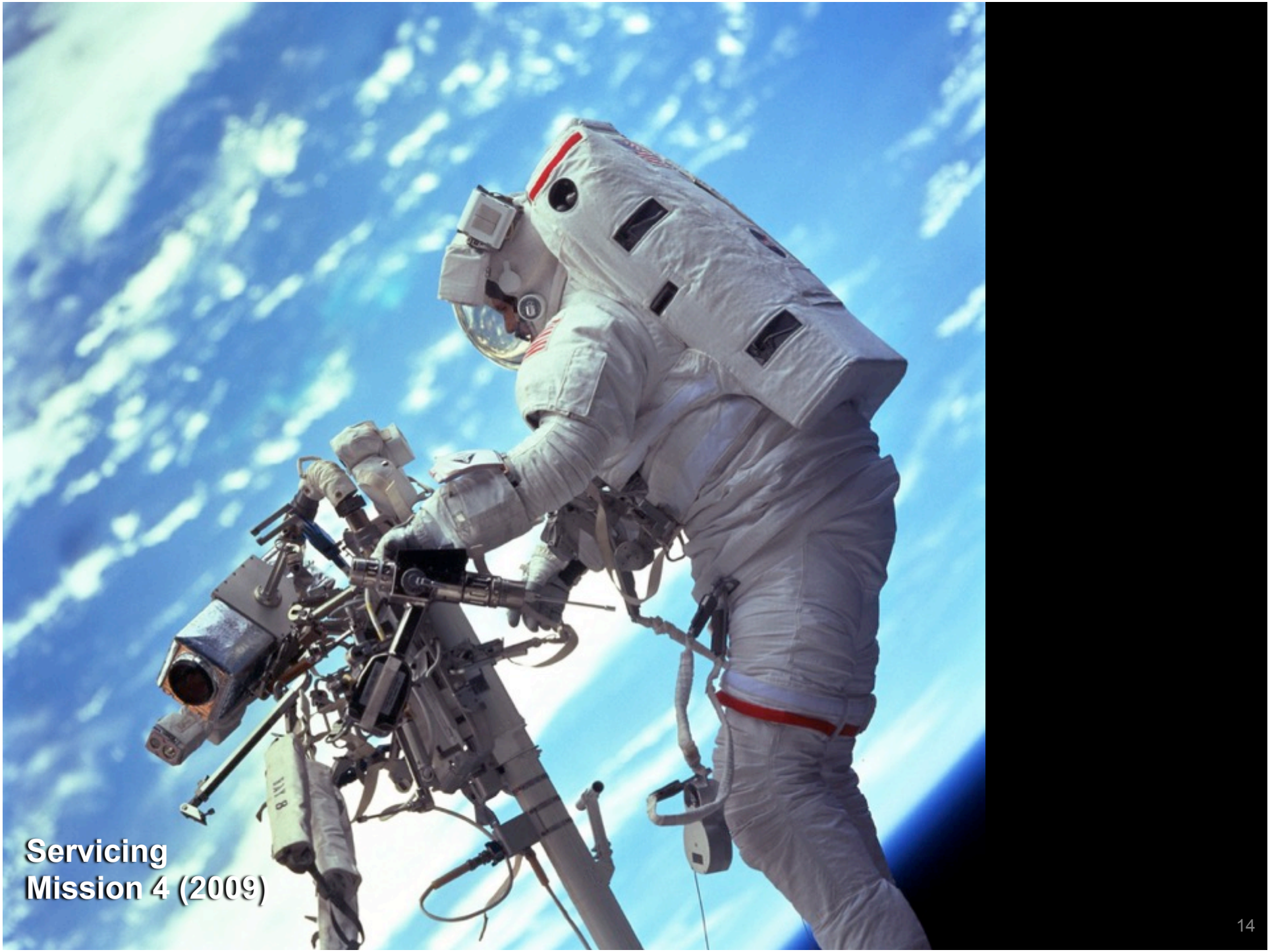
Servicing Mission 2 (1997)
Space Telescope Imaging Spectograph (STIS) and Near Infrared Camera and Multi-Object Spectrometer (NICMOS) Installation

Servicing Mission 3B (2002)

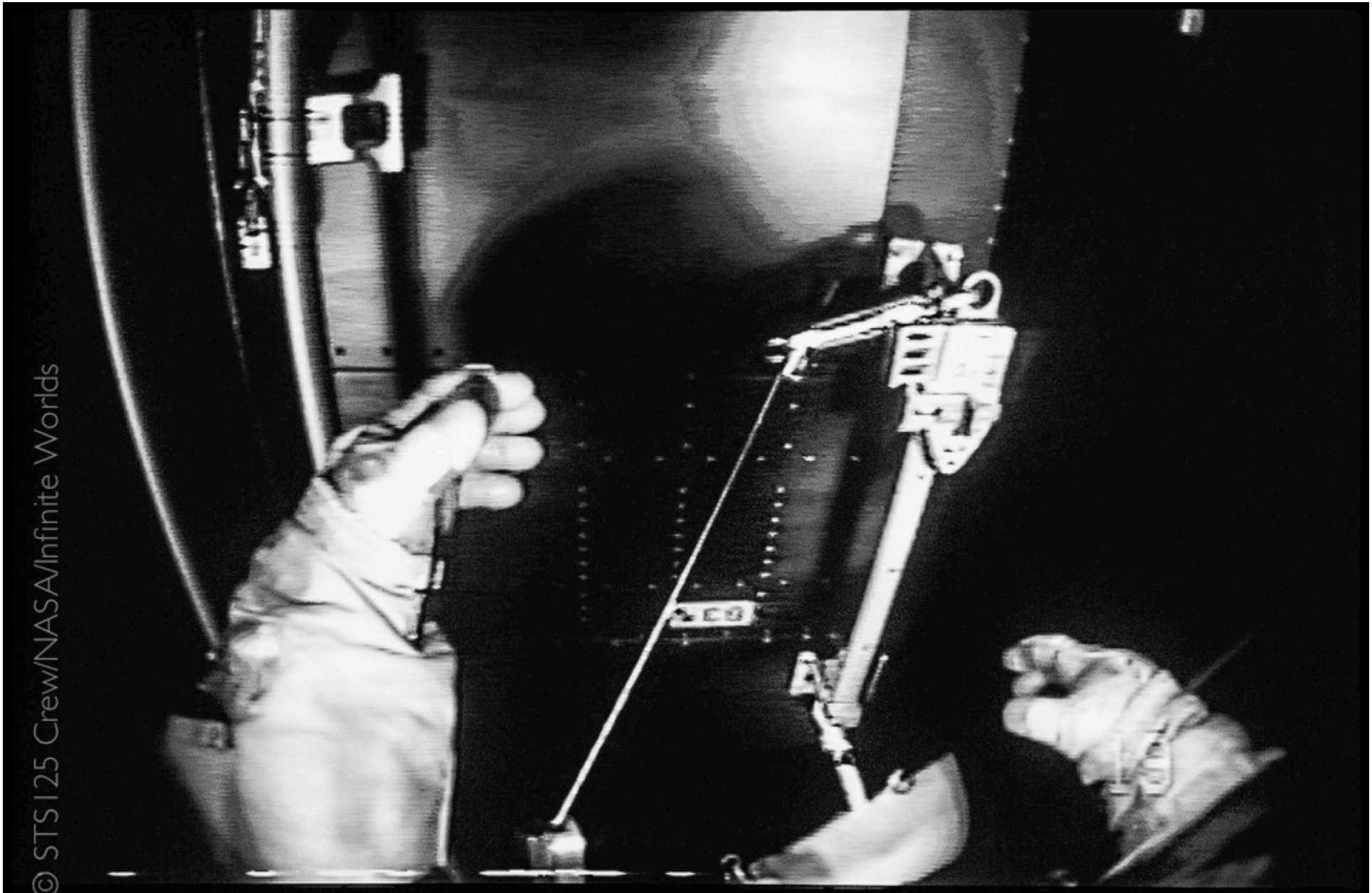
Power Control Unit (PCU) Change Out




J1
J5
ACS
J2



Servicing
Mission 4 (2009)

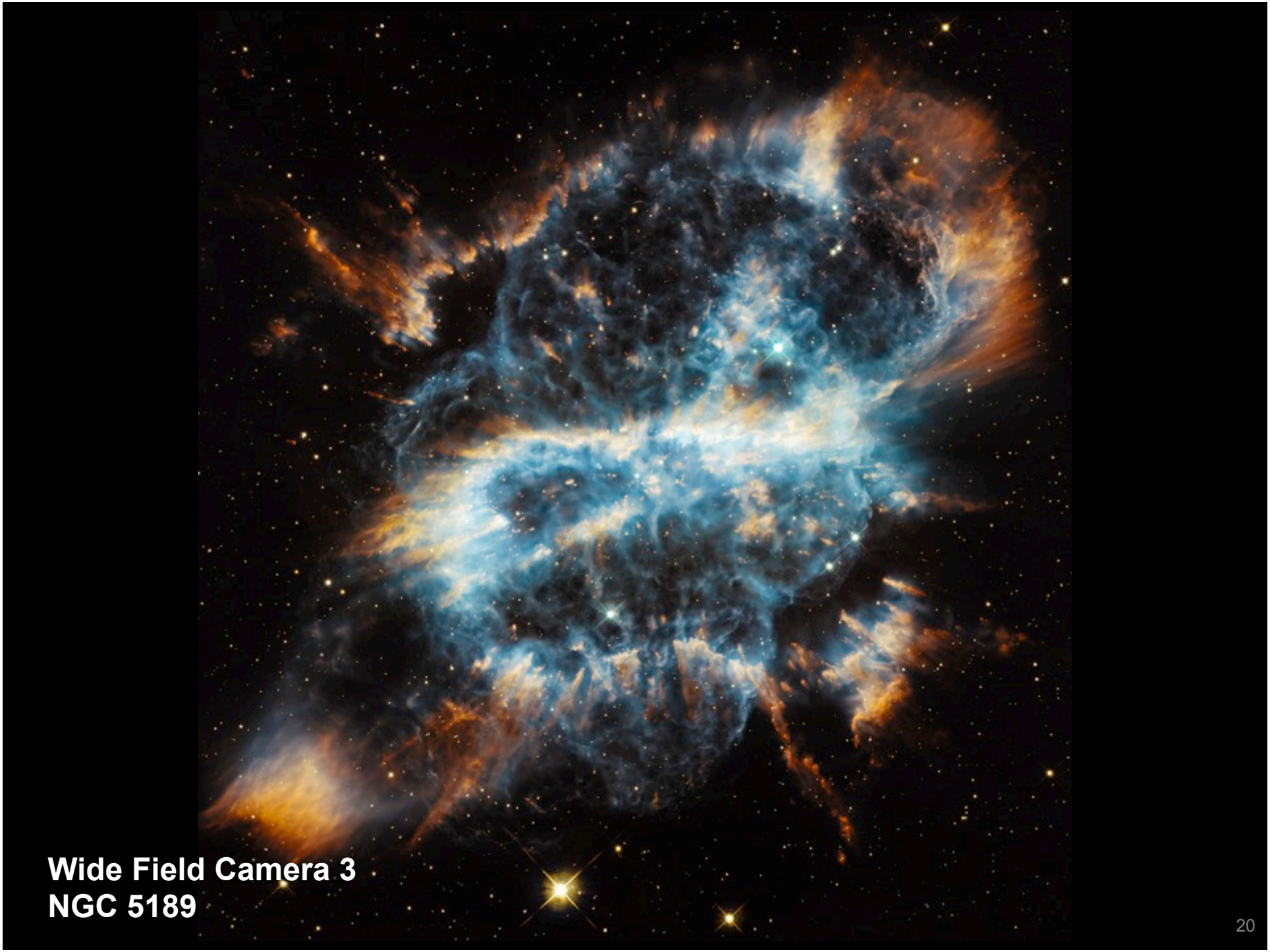


The Pivotal Moment

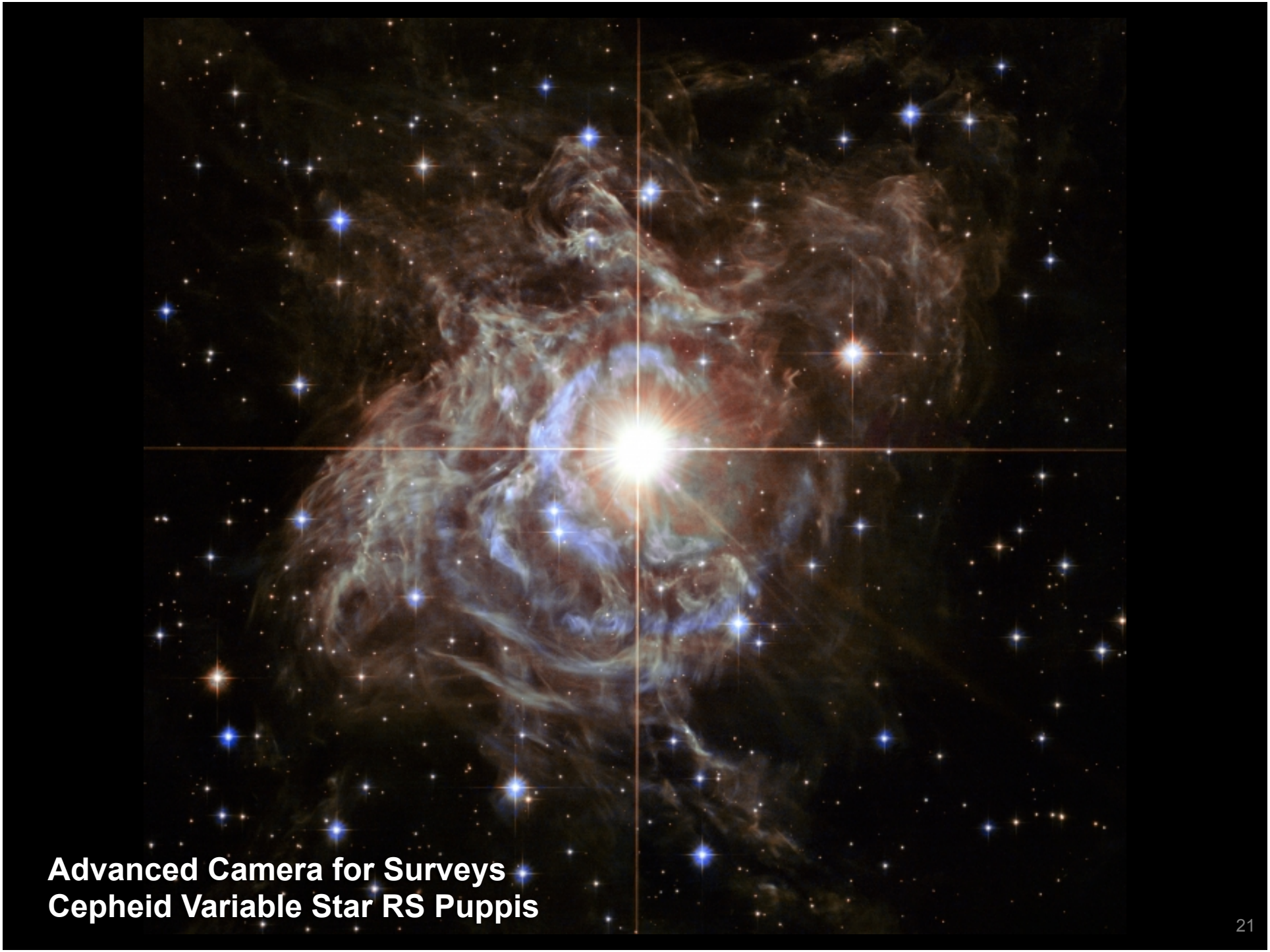
First Surgery On Orbit

Modularity in Wide Field Camera 3 (WFC3)


ORBIT OPS C/



Wide Field Camera 3
NGC 5189



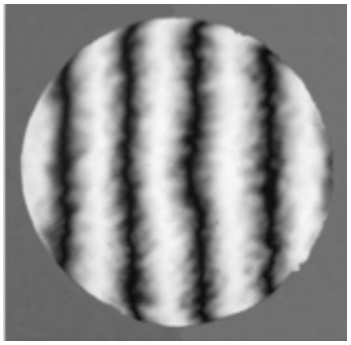
Advanced Camera for Surveys
Cepheid Variable Star RS Puppis

The Human Impact of the Hubble Servicing Missions

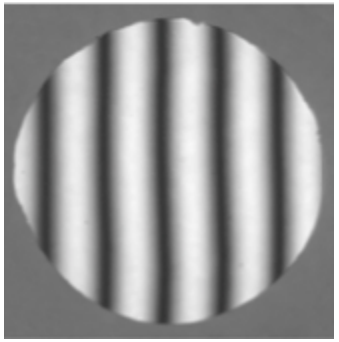
Focused on Innovation and Technology,
Driven by Our Desire to Explore

COSTAR Optics

Optical Fringe Pattern:
Demonstrates line accuracy and feature size



1990
7/10th hair



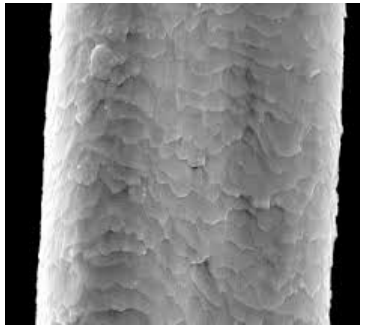
1992
1/300th hair

2015
1/1000th hair

Photolithography

COSTAR corrective optics represent a great improvement in photolithography.

Photolithography is a key process for improving transistor density on a chip.



The average human hair is ~70 microns across

Apollo Guidance Unit
(4 Kb RAM, 27 Kb memory)

iPhone 6
(1 Gb RAM, 16 Gb memory)

Processing Power:
1 iPhone 6 = **260,000** Apollo Guidance Units

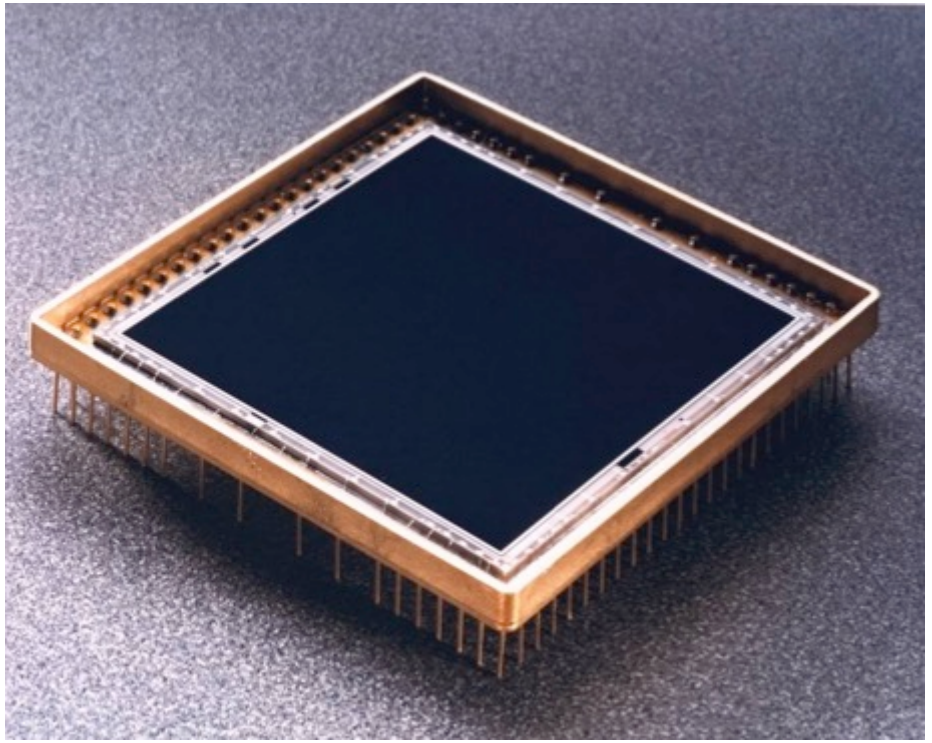
Memory:
1 iPhone 6 = **620,000** Apollo Guidance Units

7 Memory Cards can hold 1 year of Hubble data (1.825 TB)

Processing Power and Memory Storage

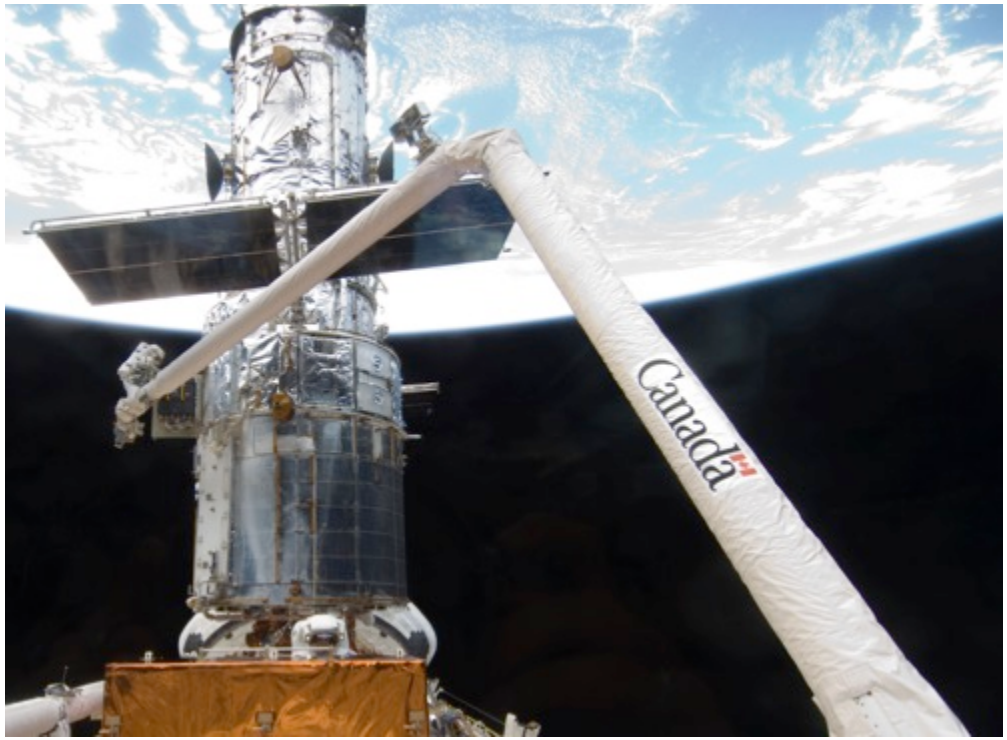
COSTAR developed better optics that improved Photolithography and therefore allowed for greater transistor density and storage capacity in a smaller volume.

Stereotactic Breast Biopsy System replaces surgery



Charge-coupled Device

A Technological Push to a Medical Reality



Robotic Technology

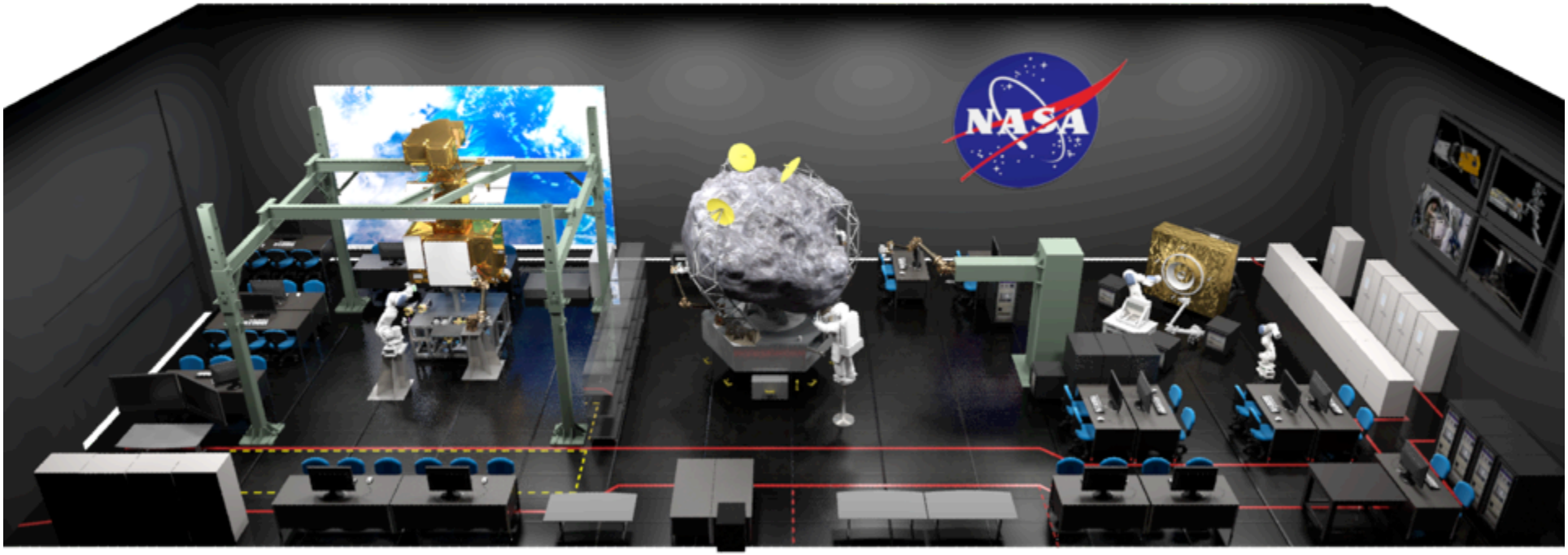
da Vinci Surgical System

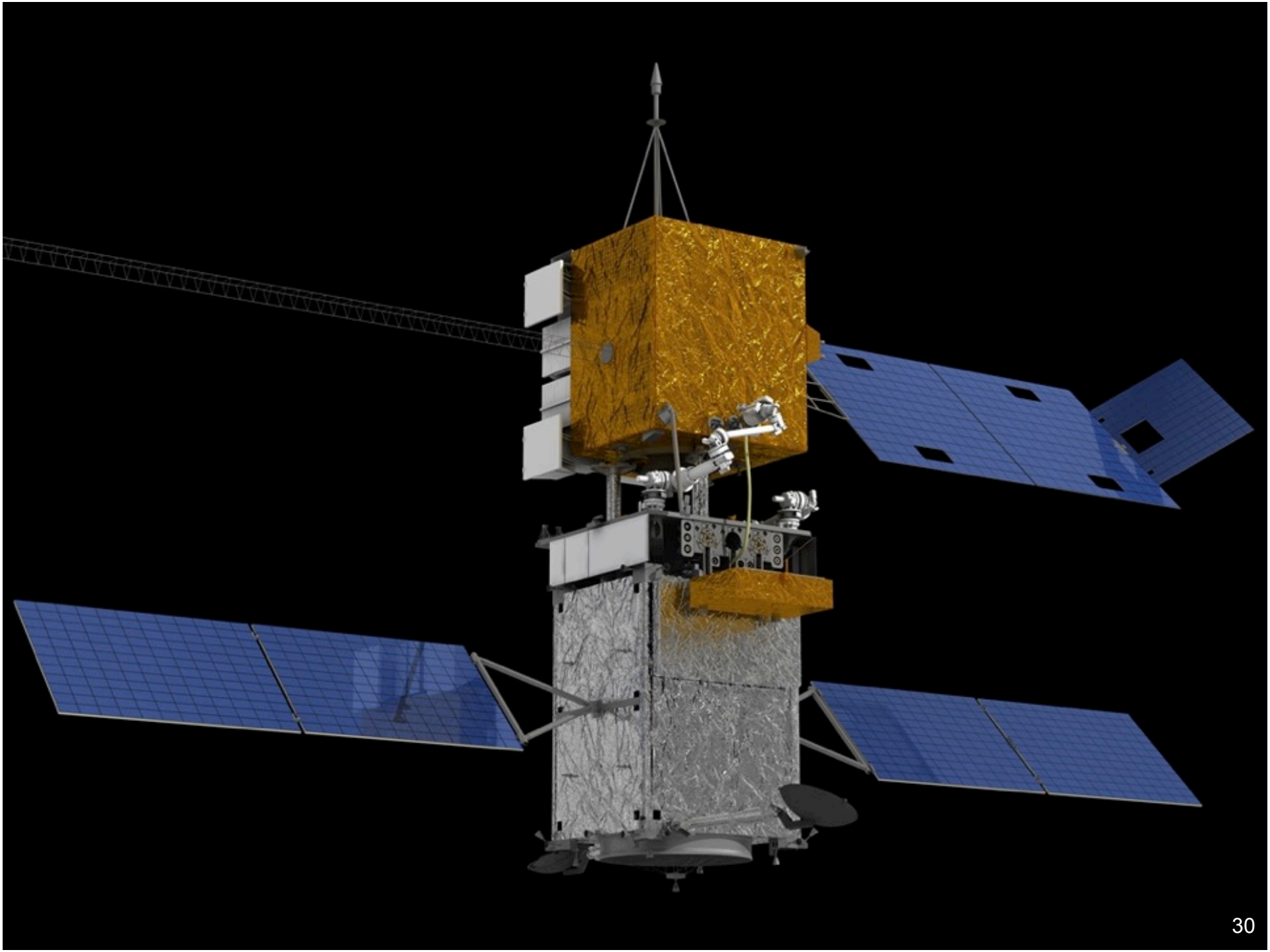
Robotic Surgery

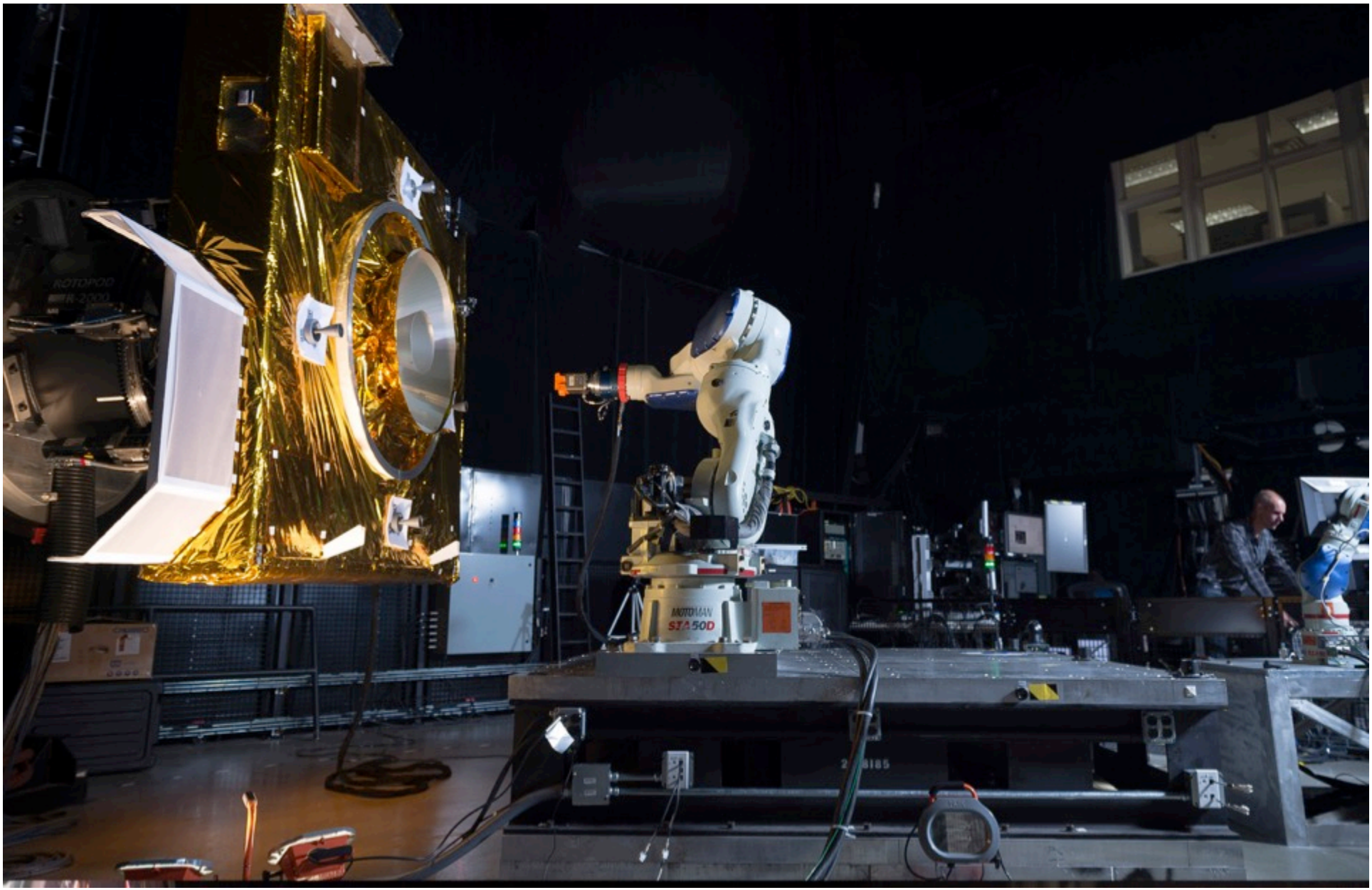
From Galileo to Today – 400 Years

What Is Next?

Where Are We Going From Here?






MOTOMAN
SIA50D